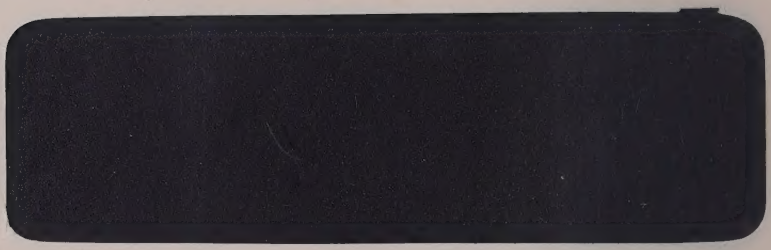
ESL 98

TRUE R.M.S. VALVE VOLTMETER TYPE 612

INSTRUCTION BOOK

DAWE INSTRUMENTS LIMITED



OPERATING INSTRUCTIONS
FOR

98

TRUE R.M.S.
VALVE VOLTMETER
TYPE 612

DAWE INSTRUMENTS LIMITED

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DAWE INSTRUMENTS LIMITED
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1. SCHEDULE OF PARTS

The complete equipment comprises the following parts:

1.1. One instrument Type 612 fitted with the following valves:—

One — ECC82 (Mullard) or 12AU7 (Brimar).

Four — EF95 (Mullard) or 6AK5.

One — 5V4G (Brimar or Mullard).

Two — 6U8 (Brimar or Mullard).

One — 85A2 (Mullard).

One — 150C4 (Mullard) or OA2.

One — 108C1 (Mullard) or OB2.

Also:—

1.2. One — Cartridge Fuse 1A for 200–250V operation, or 2A for 100–125V operation (Belling-Lee Type L1055).

One — Indicator Lamp 8V, 0·2A, M.E.S. cap (Vitality G541).

Ten — Germanium diodes (Type CV448 wired in the circuit).

1.3. One — Mains lead fitted with 3 pin socket.

1.4. Two — Jack Plugs (Igranic Type P50) for output connections.

1.5. One — Terminal screen with 3 ft. coaxial cable (C8890).

1.6. One — Instruction Book IB.612.

2. DESCRIPTION

2.1. Application

The Type 612 Valve Voltmeter has been designed to read the true root mean square value of complex signal waveforms with peak to r.m.s. ratios of up to 5 : 1 and of amplitudes between 100μV and 300V at frequencies between 5 c/s and 500 kc/s.

The instrument is essential wherever true r.m.s. readings are required, for example, for measurements associated with saturated reactors, rectifier ripple, noise generated in transistors, valves and resistors, acoustic and vibration tests and intermodulation and harmonic distortion determinations, as well as for general laboratory use at power, audio and low radio frequencies.

Most available valve voltmeters are calibrated to indicate r.m.s. values and are accurate only when the waveform is sinusoidal. The Type 612 indicates true r.m.s. values due to a specially developed squaring circuit which generates a square law function in a manner now familiar to analogue computer designers. The response is rapid and the thermal effects are negligible.

2.2. Circuit

The instrument comprises a high impedance (10MΩ) attenuator giving full scale deflections of 300μV to 300V in thirteen ranges and a wide band amplifier, stabilized by a generous amount of negative feedback. The amplifier consists of two stages with the attenuator split into two sections, one at the input and one after the first amplifier stage. Both sections are operated by a single range switch and the latter section is arranged to operate first to improve the signal-to-noise ratio at higher input levels. The amplifier output is transformer fed to a full-wave rectifier and squaring circuit.

The squaring circuit consists of eight germanium diodes arranged with suitable direct current bias and load resistors to generate a square law function by a continuous sequence of linear segments.

The synthesized square law function is accurate within 1% at all points over the dynamic input voltage range of 50 to 1. Peak voltages of up to 5 times full scale meter deflection are accurately shaped.

The response is instantaneous and is not affected by humidity, temperature or ageing. Logarithmic voltage calibration of the meter provides a constant percentage reading accuracy of 1% at all scale indications. A linear decibel scale extends the usefulness of the equipment.

The long term accuracy of the instrument is ensured by the use of a stabilized power supply, heavy negative feedback and high stability components for all vital circuits.

3. INSTALLATION

Read the label attached to the instrument and note the information given relating to the valves and power supply.

3.1. Power Supply

For supplies other than that stated on the label it will be necessary to adjust the tapping panel at the back of the instrument and if necessary change the fuse rating. (Refer Section 1.1.)

Remove the Perspex cover by unscrewing the two 4BA retaining screws. Unscrew the tapping screws and then screw them tightly into the appropriate voltage settings.

With the MAINS switch in the off position connect the instrument to the mains supply by means of the lead provided.

Red - - -	Line
Black - - -	Neutral
Other Colour -	Earth

3.2. Valves

These are normally supplied fitted in their holders. The various types used are listed in Section 1.1.

4.2.3. Non-Sinusoidal Waveforms

(*a*) *Peak to r.m.s. ratios not exceeding* 5 : 1

The accuracy of measurement is the same as for sinusoidal waveforms (Section 4.2.2.) when all the component frequencies of the complex waveform are within the linear range of the amplifier frequency response.

Component frequencies lying outside the specified frequency limits are attenuated. In practice, however, the error in measurement is small since these components are normally of a second order of magnitude.

The Type 612 can be used for measurements associated with random noise, narrow or wideband, since for all practical purposes the peak to r.m.s. ratio for random noise does not exceed 5 : 1.

(*b*) *Peak to r.m.s. ratios exceeding* 5 : 1

The overload characteristic of the amplifier, detector and squaring circuits is linear up to five times full scale meter deflection. If the complex waveform being measured contains peaks greater than five times the r.m.s. value an accurate external attenuator is required. Therefore, to measure accurately the r.m.s. value of a waveform with peak to r.m.s. ratio of, say, 10 : 1, the waveform must be attenuated by a factor of 2. A half-scale reading is then obtained and the peaks are within the linear range of the instrument.

The maximum peak to r.m.s. value which can be measured by this method is about 15 : 1, due to the 3 : 1 span of the meter scale.

4.3. R.M.S. Current Measurements

The true r.m.s. value of a current waveform can be measured with the same accuracy within the frequency limits and peak to r.m.s. ratio limits as for voltage measurements. (Sections 4.2.2 and 4.2.3 (*a*) and (*b*).) The INPUT terminals must be shunted by an accurately known resistor and connected in series with the load preferably at the low potential end with the terminal marked " E " earthed. For ease of reading the resistor can be a decimal multiple or sub-multiple of 10Ω.

The r.m.s. current is given by:—

$I = \frac{E}{R}$ where I is the current (amperes).
E is the indicated voltage (volts).
R is the shunt resistor (ohms).

4.4. Power Measurements

True a.c. power, dissipated in a known resistor, can be measured by reading the r.m.s. voltage across the resistor and using the formula:—

$P = \frac{E^2}{R}$ where P is the power (watts).
E is the indicated voltage (volts).
R is the resistor value (ohms).

The possible range of power measurement is 130dB. In 600Ω this corresponds to a range of $16{\cdot}7 \times 10^{-12}$ watts to 167 watts. Power level can be read directly on the red decibel scale, in conjunction with the multiplying factor on the range switch, and can be converted to any desired power reference level as described in the latter part of Section 4.1.

4.5. Amplifier Output

An output of approximately 5V r.m.s. corresponding to full scale deflection is available from the AMPLIFIER OUTPUT jack. This output is independent of the meter and the squaring circuit. The gain from the INPUT terminals to the AMPLIFIER OUTPUT is dependent on the range switch setting, which provides a convenient gain control in steps of 10dB. A maximum gain of approximately 84dB is obtained with the range switch set to 0·3mV full scale meter deflection.

The rated output is 5V r.m.s. into a load resistor not smaller than 20kΩ. The source impedance is approximately 50Ω, except at the lowest frequencies, when it is determined by the 16μF output coupling capacitor.

The signal from the output jack can be used for simultaneous monitoring, viewing, listening or recording of the voltage being measured by the instrument. The output signal is in phase with that of the input and care should be taken to screen external connections one from the other especially at high frequencies and low voltage levels.

5.3.3. Amplifier Gain

With the range switch set to the 0·3mV position the overall gain from the input terminals to the AMPLIFIER OUTPUT jack is approximately 84dB. An output of about 5V r.m.s. should be obtained for full scale deflection of the meter.

5.3.4. Amplifier Frequency Response

The frequency response of the amplifier is set for minimum error between 100 kc/s and 500 kc/s on the 0·3mV range by means of the inductor L1 located on the wiring side of the chassis and close to the base of V3.

5.3.5. Range Switch Accuracy

The accuracy of the various ranges at low frequencies is set by high stability resistors and should not alter unless these components are faulty.

Two pre-set controls, C2 and C3, are provided to compensate for stray capacitance in the range switch attenuators at high frequencies.

C3, located beneath the screen of the front section of the range switch, is set to give minimum error for an input at 500 kc/s on the 1V (or higher) range. If C3 is adjusted, C2 will also have to be re-set.

C2, located beneath the screen of the front section of the range switch, is set to give minimum error at 500 kc/s on the 30mV, 100mV or 300mV range.

5.3.6. Voltage Regulator Tubes

Unduly high susceptability of the instrument to transient signals and mains voltage surges can often be eliminated by replacing the voltage regulator tubes V9 (OA2/150C4) and V10 (OB2/108C1).

If the reference tube V8 (85A2) is replaced the gain setting should be checked as described in Section 5.3.2.

6. SPECIFICATION

Voltage Range: Thirteen voltage ranges are provided with full scale meter deflections of 300μV, 1mV, 3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, 300V.

Accuracy: Amplifier response does not vary more than $\pm$3% from 15 c/s to 150 kc/s, and $\pm$5% from 5 c/s to 15 c/s and 150 kc/s to 500 kc/s for sine waves.

For complex waves, amplifier response does not vary more than $\pm$3% for all component frequencies from 15 c/s to 150 kc/s, and $\pm$5% from 5 c/s to 500 kc/s, and peak to r.m.s. ratios not greater than 5 at full scale deflection or corresponding greater ratios at smaller meter readings. Uniform accuracy of 1% of scale reading obtained with logarithmic scale calibration.

Input Impedance: Up to 10mV approximately equivalent to a resistance of 10MΩ in parallel with a capacitance of about 38pF and about 15pF on higher ranges.

Scale Calibration: Meter calibrated in r.m.s. values. Voltage scale approximately logarithmic, calibrated 1 to 3·2 and 3·1 to 10. Linear decibel scale provided 0 to 10dB. Reference level 0dB=1V.

Amplifier Output: Approx. 5V r.m.s. at F.S.D. Source impedance 50Ω approx. Minimum load resistance 20kΩ. Maximum gain 84dB approx.

Mean Square Output: A direct voltage negative to earth representing the mean square value of the measured signal, approx. 0·2V at F.S.D.

Power Supply: 100–125V and 200–250V, 50-60 c/s, 75W approx.

Mounting: Light weight portable metal cabinet finished black with polished metal bezels.

Dimensions: $8\frac{1}{4}$ in. $\times$ 13 in. $\times$ $12\frac{1}{2}$ in. high (210 mm $\times$ 330 mm $\times$ 320 mm).

Weight: 22 lb (10·0 kg) approx.

7. GUARANTEE

Our products are carefully inspected and submitted to comprehensive tests at our factory before despatch. We therefore give to all purchasers (subject to the terms of payment and all the customer's other obligations being strictly observed) the following guarantee, which excludes and takes the place of any condition or warranty implied by Statute or otherwise.

If within three years from the date of despatch, any defect is discovered in any apparatus in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense, provided notice is given to us as soon as it is discovered, and that the apparatus is immediately forwarded to our factory, carriage paid and with seals unbroken. Our responsibility is in all cases limited to the cost of making good the defect in the apparatus itself. This guarantee is given to our customers and does not extend to third parties, nor does it apply to defects caused by wear and tear, abnormal conditions of working, accident, misuse or neglect.

In the case of material or components not of our manufacture, we are prepared to give the customer the benefit of any guarantee given us in respect thereof.

8. SERVICING PROCEDURE

The information given in this booklet should enable the user to maintain the equipment in proper working order. If difficulties arise, please write or telephone our Service Department or our Representative or Agent for your area or country. In certain cases we may be able to arrange for an outside service engineer to call on you.

When contacting our Service Department please mention the serial and type numbers of your instrument and include a full report of the fault encountered, as well as details of the action taken to eliminate it.

This information should be addressed to:

Please note new address:
WESTERN AVENUE,
ACTON, LONDON, W.3.
Telephone: ACOrn 6751

If the equipment is returned for service, please include a copy of any relevant correspondence, together with all the accessories and the Instruction Book.

This procedure will facilitate the work of our Service Department and expedite the return of the instrument.

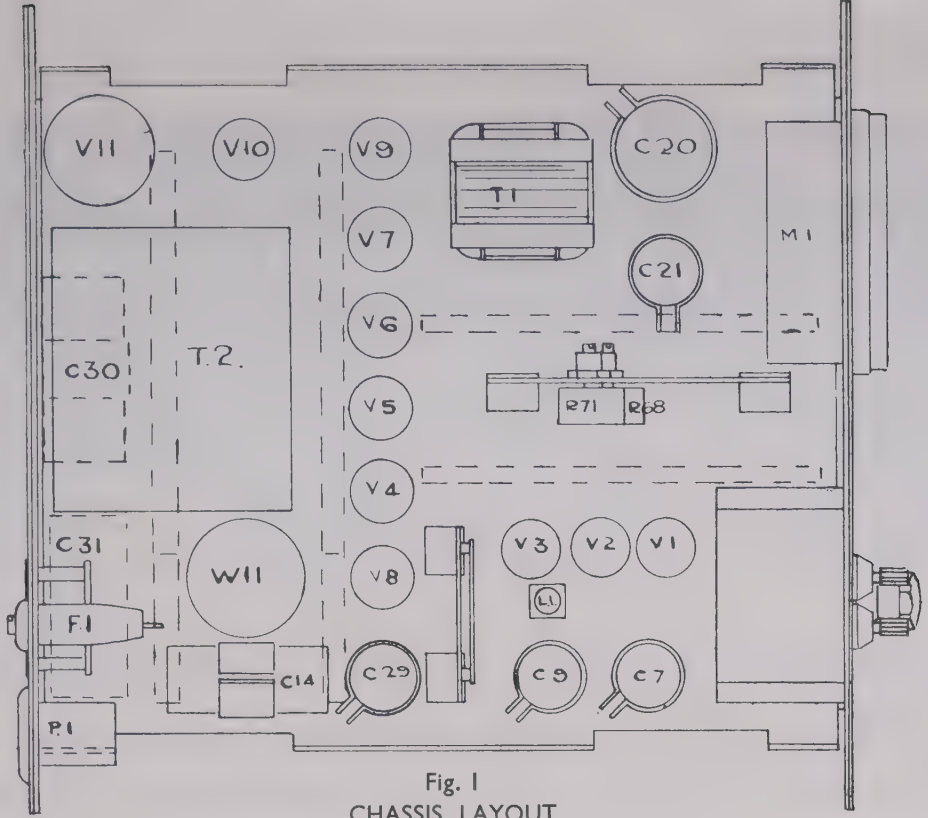


Fig. 1
CHASSIS LAYOUT
SHOWING MAIN COMPONENTS (C8993)
TYPE 612A

Cir. Ref.		RESISTORS	Tol.
R 1	338kΩ	Welwyn Type C22	±1%
R 2	10MΩ	Welwyn Type C24	±1%
R 3	9·7kΩ	Welwyn Type C22	±1%
R 4	316Ω	Welwyn Type C22	±1%
R 5A/B	22MΩ	Welwyn Type C23	±5%
R 6A	8MΩ	Welwyn Type C24	±1%
R 6B	5MΩ	Welwyn Type C24	±1%
R 7	470Ω	Erie Type 16 or Morganite Type S ...	±10%
R 8	47kΩ	Welwyn Type C22	±5%
R 9	2·2kΩ	Erie Type 9	±10%
R10	22Ω	Welwyn Type C22	±1%
R11	470Ω	Erie Type 16 or Morganite Type S ...	±10%
R12	82kΩ	Erie Type 8	±10%
R13	2·2MΩ	Erie Type 16 or Morganite Type S ...	±10%
R14	15kΩ	Erie Type 8	±5%
R15	330Ω	Erie Type 16 or Morganite Type S ...	±10%
R16	6·8kΩ	Erie Type 2	±10%
R17	47kΩ	Erie Type 8	±5%
R18	2·2MΩ	Erie Type 16 or Morganite Type S ...	±10%
R19	10kΩ	Erie Type 16 or Morganite Type S ...	±5%
R20	15kΩ	Welwyn Type C22	±5%
R21	330Ω	Erie Type 16 or Morganite Type S ...	±10%
R22	15kΩ	Erie Type 8	±5%
R23	15kΩ	Welwyn Type C22	±1%
R24	4·7kΩ	Welwyn Type C22	±1%
R25	1·5kΩ	Welwyn Type C22	±1%
R26	694Ω	Welwyn Type C22	±1%
R27	7·5kΩ	Erie Type 2	±10%
R28	47kΩ	Welwyn Type C22	±5%
R29	240Ω	Welwyn Type C22	±1%
R30	330kΩ	Erie Type 9	±10%
R31	3·3kΩ	Erie Type 16 or Morganite Type S ...	±10%
R32	3·3kΩ	Erie Type 16 or Morganite Type S ...	±10%
R33	2·2MΩ	Erie Type 16 or Morganite Type S ...	±10%
R34	2·2MΩ	Erie Type 16 or Morganite Type S ...	±10%
R35	15kΩ	Erie Type 8	±5%
R36	15kΩ	Erie Type 8	±5%
R37	330Ω	Erie Type 16 or Morganite Type S ...	±10%
R38	20kΩ	Welwyn Type C22	±5%
R39	22kΩ	Welwyn Type C22	±5%
R40	10kΩ	Welwyn Type AW3111	±5%
R41	10kΩ	Welwyn Type AW3111	±5%
R42	330Ω	Erie Type 16 or Morganite Type S ...	±10%
R43	330Ω	Erie Type 16 or Morganite Type S ...	±10%
R44	2·2MΩ	Erie Type 16 or Morganite Type S ...	±10%
R45	47kΩ	Welwyn Type C22	±5%
R46	1·5kΩ	Erie Type 16 or Morganite Type S ...	±10%
R47	47kΩ	Erie Type 8	±10%
R48	22kΩ	Welwyn Type C22	±5%
R49	6·45kΩ	Welwyn Type C23	±1%
R50	34·3kΩ	Welwyn Type C23	±1%
R51	1·5kΩ	Erie Type 16 or Morganite Type S ...	±10%
R52	13·7kΩ	Welwyn Type C23	±1%

Cir. Ref.		RESISTORS	Tol.
R53	129kΩ	Welwyn Type C23	±1%
R54	2·2MΩ	Erie Type 16 or Morganite Type S ...	±10%
R55	1kΩ	Welwyn Type C22	±5%
R56	18·7kΩ	Welwyn Type C23	±1%
R57	311kΩ	Welwyn Type C23	±1%
R58	31·1kΩ	Welwyn Type C23	±1%
R59	694kΩ	Welwyn Type C23	±1%
R60	100kΩ	Erie Type 16 or Morganite Type S ...	±10%
R61	46kΩ	Welwyn Type C23	±1%
R62	1·55MΩ	Welwyn Type C23	±1%
R63	68kΩ	Welwyn Type C23	±1%
R64	3·48MΩ	Welwyn Type C23	±1%
R65	94·4kΩ	Welwyn Type C23	±1%
R66	7·23MΩ	Welwyn Type C23	±2%
R67	22kΩ	Erie Type 2	±10%
R68	10kΩ	Pot. Morganite Type A Lin. Pre-Set ...	
R69	78·5kΩ	Welwyn Type C23	±1%
R70	10MΩ	Welwyn Type C23	±2%
R71	500kΩ	Pot. Morganite Type A Lin. Pre-Set ...	
R72	470kΩ	Erie Type 16 or Morganite Type S ...	
R73	470kΩ	Erie Type 16 or Morganite Type S ...	
R74	3·3kΩ	Welwyn Type AW3112	±5%
R75	4·7kΩ	Welwyn Type AW3115	±5%
R76	2·2Ω	Welwyn Type AW3115	±10%

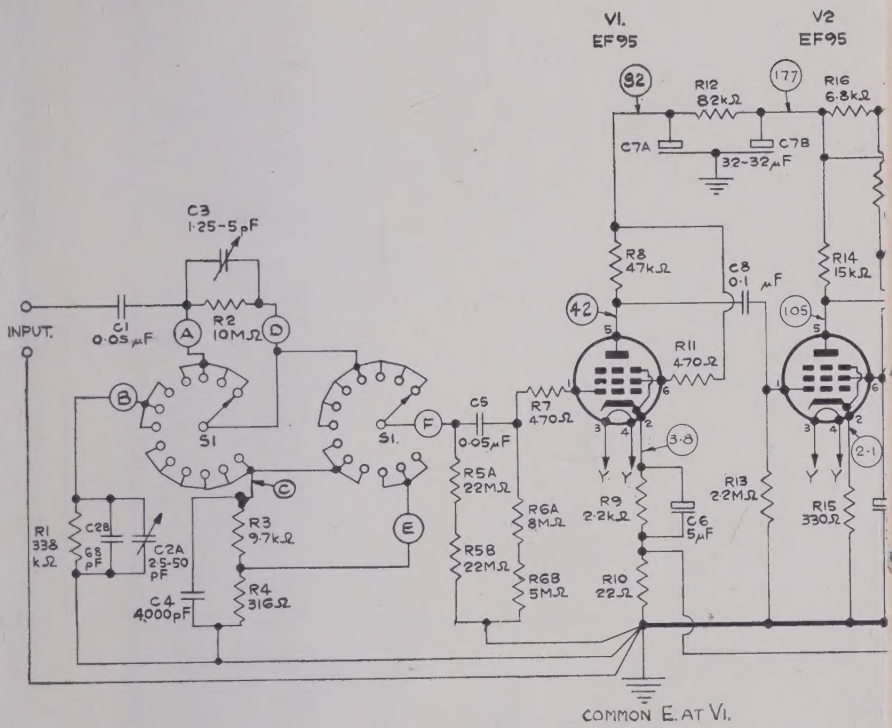
Cir. Ref.		CAPACITORS		Wkg. Volts
C1	0·05μF	Hunts Type AF118		1,000
C2A	2·5–50pF	Oxley Type A7/47·5		500
C2B	68pF	Dubilier Type S635 ...	±20% ...	350
C 3	1·25–5pF	Wingrove & Rogers C32–01		
C 4	3000pF	Hunts Type H1354A ...	±10% ...	500
C 5	0·05μF	Hunts Type A305	±25% ...	350
C 6	5μF	T.C.C. Type CE59D		50
C 7	32–32μF	T.C.C. Type CE34HE		275
C 8	0·1μF	T.C.C. Type CP45N ...	±25% ...	350
C 9	32μF	T.C.C. Type CE19LE		350
C10	0·01μF	T.C.C. Type CP32N ...	±25% ...	350
C11	200μF	Hunts List No. JF2T		6
C12	8μF	Hunts List No. JF251T		275
C13	16μF	T.C.C. Type CE18HE		275
C14	16–16μF	T.C.C. Type CE34LE		350
C15	0·01μF	T.C.C. Type CP32N ...	±25% ...	350
C16	47pF	Dubilier Type S635 ...	±10% ...	350
C17	47pF	Dubilier Type S635 ...	±10% ...	350
C18	0·05μF	T.C.C. Type CP35N ...	±25% ...	350
C19	10pF	Dubilier Type S635 ...	±10% ...	350
C20	200–200μF	T.C.C. Type CE36HE		275
C21	32–32μF	T.C.C. Type CE34HE		275
C22	0·01μF	T.C.C. Type CP32N ...	±25% ...	350
C23	20μF	Hunts List No. JF155T		150

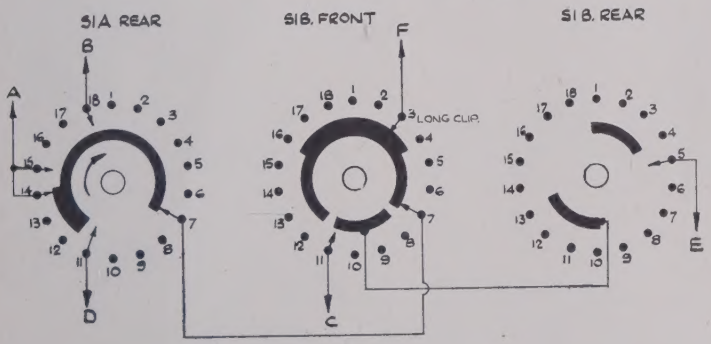
CAPACITORS

Cir. Ref.					Wkg. Volts
C24	100μF	T.C.C. Type CE59AE	...	... ...	6
C25	0·05μF	T.C.C. Type CP35N	...	±25% ...	350
C26	16μF	T.C.C. Type CE18HE	...	... ...	275
C27	0·05μF	T.C.C. Type CP35N	...	±25% ...	350
C28	0·01μF	T.C.C. Type CP32N	...	±25% ...	350
C29	32μF	T.C.C. Type CE13PE	...	... ...	450
C30	8μF	T.C.C. Type CE10PA	...	... ...	500
C31	1000μF	T.C.C. Type CE10B	...	... ...	12

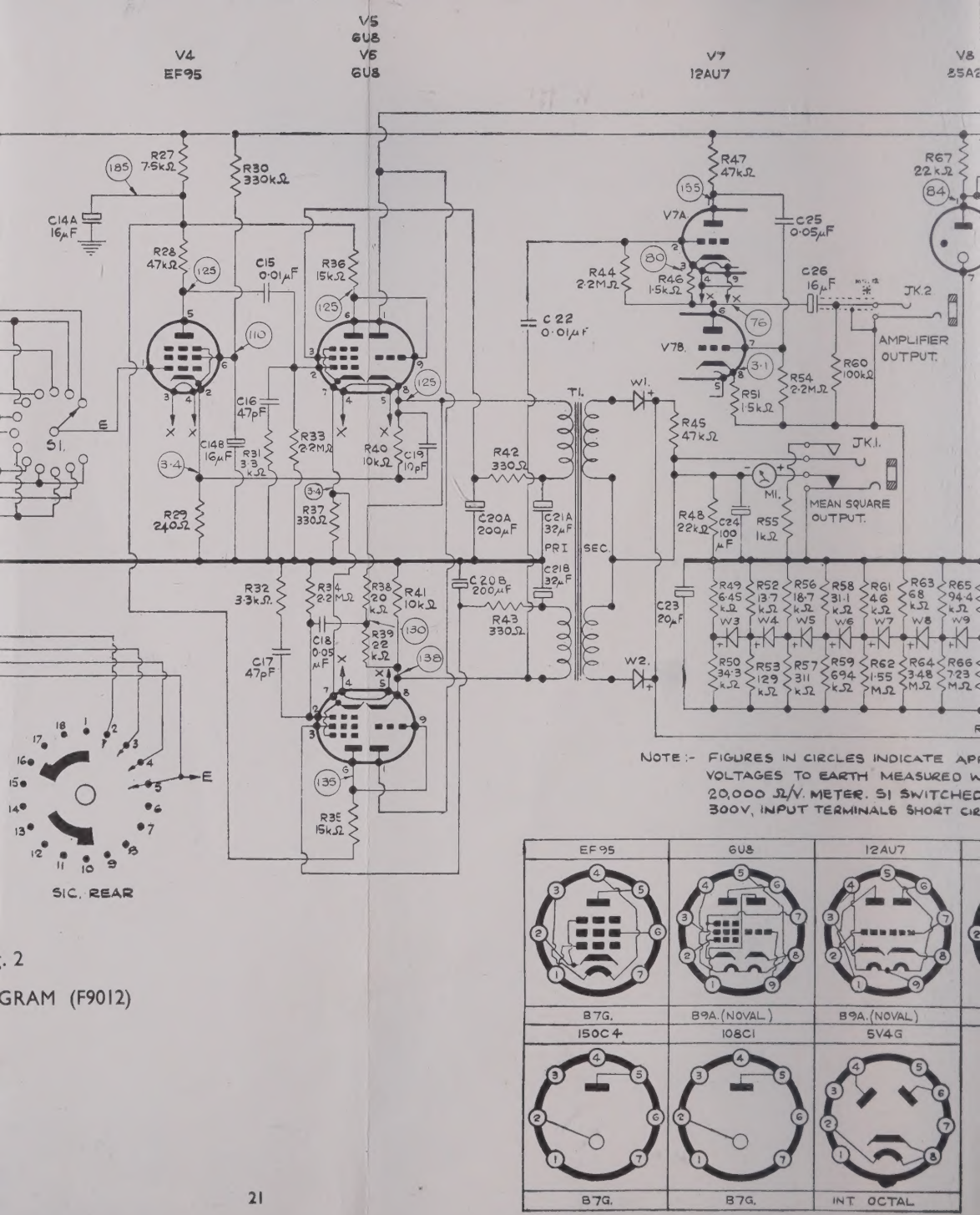
MISCELLANEOUS

Cir. Ref.	
F1	Fuse Belling Lee L1055, 1 amp for 200–250V operation, 2 amp for 100–125V operation
JK1	Jack, Igranic, P74
JK2	Jack, Igranic, P71
L1	0·8–3mH Osmor Type QA6
LP1	Pilot Lamp 8V 0·2A M.E.S. Cap. Vitality G541
M1	Meter 200μA d.c. Sangamo Weston S157·1·138 (Scale to drg. No. C9065)
P1	Plug Bulgin Q573
S1	Oak Switch N.S.F. to D.I. drg. No. C9001
S2	Switch N.S.F. 8370/K8
T1	Output Transformer, Partridge Type, D4148
T2	Mains Transformer, Partridge Type, D3388/P
TP1	Mains Tapping Panel, Carr Fastener Type 75/996 (Engraved Plate to drg. No. A7722)
V 1	Valve, Mullard, EF95 or 6AK5
V 2	Valve, Mullard, EF95 or 6AK5
V 3	Valve, Mullard, EF95 or 6AK5
V 4	Valve, Mullard, EF95 or 6AK5
V 5	Valve, Brimar or Mullard, 6U8
V 6	Valve, Brimar or Mullard, 6U8
V 7	Valve, Brimar 12AU7 or Mullard ECC82
V 8	Valve, Mullard, 85A2
V 9	Valve, Mullard, 150C4 or OA2
V10	Valve, Mullard, 108C1
V11	Valve, Brimar or Mullard, 5V4G
W1–10	Crystal Diode Type CV448
W11	Selenium Rectifier S.T.C. Type V45–1–1W





PHYSICAL ARRANGEMENT OF S1
(SHOWN ON 0·3 mV. F.S.D. RANGE)



NOTE :- FIGURES IN CIRCLES INDICATE APP
VOLTAGES TO EARTH MEASURED W
20,000 Ω/V. METER. S1 SWITCHED
300V. INPUT TERMINALS SHORT CI

. 2

GRAM (F9012)

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